APPENDIX C
AIR QUALITY IMPROVEMENT: 1986 - 1996

The Bay Area has a comprehensive monitoring network consisting of 23 ozone monitors. The present network provides good geographical coverage, and includes source areas, populated areas, and downwind concentration areas. The system has scored well on audits conducted by the EPA and ARB.

ARB requires that several measures of monitored air quality data be analyzed. One such measure is the "design value,"[1] a measure of peak pollutant concentrations. Other measures include population- and area-weighted exposure. Each of these measures has been computed for the Bay Area in this appendix, illustrating changes from a base period (1986-88) to the current period (1994-96).

Design Value

The design value serves as a measure of worst-case exposure and it relates directly to progress in achieving the state ambient air quality standard. The Bay Area exceeds the state ozone (O_3) standard at about two thirds of its monitoring sites.

In general, any concentration exceeding the standard is considered a violation of a state standard, but there are two kinds of exceptions. One is exceptional events. These are cases deemed by ARB to be beyond regulatory control, such as forest fires or dust storms. The other class of exceptions is extreme concentration events. These are concentrations determined by ARB to occur less than once per year on the average.

In order to identify extreme concentration events for a particular monitoring site, ARB computes a design value based on the most recent three years of data available. A design value is an estimate of that concentration that would occur once per year on the average. Any measured concentration that exceeds this design value can be excluded as an extreme concentration event. If there were no other exceedances of the standard, then that site would comply with the standard.[2]

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[1] The term *design value* is used instead of a California air quality planning term, *expected peak day concentration.* The calculation used to derive design value is consistent with ARB's methodology for calculating expected peak day concentration.

[2] This plan addresses the California state ozone standard (0.09 parts per million one-hour average). The national one-hour ozone standard is similar in form to the state standard, but is set at 0.12 parts per million. Like the state standard, it can be exceeded once per year on the average. The only difference in form is how "on the average" is defined. The national ozone standard allows up to three exceedances in three years or, literally, one exceedance per year averaged over the most recent three years. In contrast, the state's method estimates a threshold above which anywhere from zero to five or six exceedances might be found in practice, due to the state's exclusion of extreme concentration events.

Ozone Design Values And Trends

Table C-1 lists design value estimates for the 1986-88 base period, the 1991-93 period covered in the 1994 Clean Air Plan, and the current period, 1994-96. Listed, with one exception[3] are all Air District ozone monitoring sites in operation during the entire period. In the base period, design value estimates ranged from 7.4 pphm for San Francisco to 14.7 pphm for Alum Rock (near San Jose). Livermore, a site which has experienced recent exceedances of the national ozone standard, had a base period design value of 14.5 pphm.

TABLE C-1

OZONE DESIGN VALUE (DV) ESTIMATES AND TRENDS: 1986-1996

	Design Value Estimates (pphm)[a]			Annual Percentage DV Change[b]		
Monitoring Site[c]	1986-88 base period	1991-93 (1)	1994-96 (2)	base to (1)	(1) to (2)	base to (2)
San Francisco	7.4[c]	5.9	**6.4**	-3.9	2.7	-1.7
Oakland	8.2[c]	6.7	**6.8**	-3.7	0.8	-2.1
Richmond	8.3[c]	7.8	**8.0**	-1.4	0.9	-0.5
Santa Rosa	8.7[c]	8.0	**8.5**	-1.5	2.0	-0.2
Sonoma	10.1	9.1	**8.6**	-2.1	-1.6	-1.8
San Rafael	9.3[c]	7.5	**8.8**	-4.0	6.1	-0.7
Redwood City	9.7	7.4	**9.8**	-4.8	11.0	0.1
Mountain View	14.0	9.7	**10.3**	-6.1	2.0	-3.3
Vallejo	10.9	9.5	**10.5**	-2.6	3.5	-0.5
Napa	10.7	9.7	**10.6**	-1.8	3.0	-0.1
Hayward	12.9	8.9	**11.1**	-6.2	8.3	-1.7
Bethel Island	11.1	10.9	**11.2**	-0.5	0.9	0.0
Fairfield	11.1	10.3	**11.4**	-1.4	3.5	0.3
San Jose	13.1	10.8	**11.6**	-3.5	2.6	-1.4
Pittsburg	11.7	10.3	**11.6**	-2.3	4.3	0.0
Fremont	13.2	11.1	**11.8**	-3.3	2.1	-1.4
Gilroy	14.2	11.6	**12.0**	-3.7	1.2	-2.0
Concord	12.8	10.7	**12.5**	-3.2	5.4	-0.3
Los Gatos	13.9	12.0	**12.5**	-2.8	1.6	-1.3
Alum Rock	14.7	11.7	**12.5**	-4.1	2.4	-1.8
Livermore	14.5	12.7	**15.1**	-2.4	6.1	0.5
Averages	*11.5*	*9.6*	***10.6***	*-3.1*	*3.3*	*-0.9*

[a] Design value estimates computed using ARB's *RECRATE* computer program. Each estimate is based on 3 years of daily high hour ozone data, with *RECRATE* calculating a value roughly equivalent to the 4th high over the 3 year period.

[b] Estimated percentage change equals 100(a-b)/(nb), where a is the more recent design value, b is the earlier value and n is the number of years between them.

[c] Shaded sites met the California standard during 1994-96. Sites with values labeled with a "c" met the California state standard during 1986-88.

[3] The San Leandro site did not provide reliable information during part of this period, so it was not included in the analysis. Ozone concentrations in the San Leandro area are usually in the range of those measured in Oakland or Hayward.

Ozone-conducive weather in the 1995 and 1996 ozone seasons resulted in higher design values and exposures, compared to the previous triennial reporting period (1991-93). Currently, 6 of the 21 sites meet the state ozone standard, down from 8 out of 21 in the 1991-93 period. The last three columns of Table C-1 show annual rates of change in design values. All sites showed a decrease between the 1986-88 base period and the 1994 Clean Air Plan analysis period, 1991-93. Almost all sites showed an increase from the previous period to the present. However, even with the unusually high ozone in 1995 and 1996, the average design value of all sites decreased approximately one percent per year between the base period and 1994-96.

Ozone concentrations vary from day to day due to "chance" variation induced by the weather. One summer day may be hot with calm winds, another summer day may be cool and windy throughout the region. Ozone concentrations vary considerably based on such weather factors, and thus design value estimates, which are based on these concentrations, will also vary. There are statistical techniques to remove--at least partially--the effects of meteorology from the design value estimates. Since Livermore showed an increase in design value since the base period, a design value was calculated for that air monitoring site to illustrate the change in ozone without the effect of meteorology. Ozone levels in Livermore would have dropped approximately one percent per year with no meteorological influence.

Population and Area-Weighted Exposures

Population- and area-weighted exposure calculations provide meaningful measures of air quality improvement for ozone. Ozone design values provide information on worst-case exposures, but not aggregate exposure; design values do not indicate whether only a few people or many people are being exposed. Population exposure provides a better indication of the extent and severity of the ozone problem for human health. Moreover, the rate of progress in reducing average exposure can be very different from the progress in reducing peak ozone levels. In particular, small decreases in peak ozone translate into large decreases in exposure. Thus, even though the rate of improvement in reducing peak ozone values may be modest, the reduction in ozone-related health effects may be substantial.[4]

Population exposure is a summation of the exposures of all Bay Area residents to harmful ozone levels during a specified period. This analysis compares population exposure for three periods: 1986-88, 1991-93 and 1994-6. Area-weighted exposure is similar except that it is the summation of exposures of land areas rather than residents. The rationale for calculating area-weighted exposures is to estimate the exposure of crops and vegetation to the damaging effects of ozone.

[4] When the '91 CAP was prepared, the CCAA mandated that Bay Area population exposure be reduced by 25% from 1986-88 levels by December 1994 and 40% by December 1997. A 1992 amendment to the CCAA removed this requirement by reclassifying the Bay Area from a "severe" to a "serious" ozone nonattainment category. Nevertheless, the reduction in Bay Area population exposure has achieved these targets.

Population Exposure to Ozone

Table C-2 lists estimated per capita exposures for the 1986-88 base period, the 1991-93 period calculated for the 1994 Clean Air Plan, and the current 1994-96 period by county. Also listed are the percentage reductions in estimated exposure.

TABLE C-2: POPULATION EXPOSURE TO OZONE

County	Per Capita Exposure (person-pphm-hours above 9.5 pphm/total population)			Percent Decrease	
	1986-88	1991-93	1994-96	1986-88 to 1991-93	1986-88 to 1994-96
Alameda	14.0	4.2	11.4	70	18
Contra Costa	12.6	3.6	10.5	71	16
Marin	0.3	0.1	0.4	65	-25
Napa	2.5	2.2	4.4	14	-75
San Francisco	0.0	0.0	0.0	not applicable	not applicable
San Mateo	2.0	0.2	2.4	91	-18
Santa Clara	24.2	3.9	7.7	84	68
Solano[a]	7.4	2.7	6.9	64	8
Sonoma[a]	0.7	0.1	0.2	82	67
Bay Area	11.5	2.6	6.6	77	43

[a] Only that portion of the county within the Air District jurisdiction is included.

Bay Area wide, there was an estimated decrease of 77% in exposure between the 1986-88 period and the 1991-93 period, but increases in exposure from 1991-93 to 1994-96. Bay Area wide, there has been a net decrease of 43% from 1986-88 to 1994-96, but progress was not uniform. Santa Clara has shown a dramatic 68% decrease in exposure and Sonoma County has shown a similar decrease, but for the core of the Bay Area the changes have been small. Napa County has shown an increase in exposure, but the number of residents affected is comparatively smaller.

Area-Weighted Exposure

Area-weighted exposure is defined similarly to population exposure except that census tract area replaces census tract population. Thus it is the summation of the products of census tract areas (in square kilometers) and ozone excess above the standard. Table C-3 presents area-weighted exposure by county.

TABLE C-3: AREA-WEIGHTED EXPOSURE TO OZONE

County	Area-Weighted Exposure[a]			Percent Decrease	
	1986-88	1991-93	1994-96	1986-88 to 1991-93	1986-88 to 1994-96
Alameda	29.3	7.6	21.8	74	26
Contra Costa	18.9	5.1	16.5	73	13
Marin	0.2	0.1	0.2	74	9
Napa	2.8	1.7	3.5	41	-23
San Francisco	0.0	0.0	0.0	not applicable	not applicable
San Mateo	2.5	0.2	2.2	92	9
Santa Clara	30.4	6.1	10.3	80	66
Solano[b]	8.0	2.8	7.5	65	7
Sonoma[b]	1.1	0.3	0.5	77	56
Bay Area	14.0	3.5	8.9	75	36

[a] Units are km^2-pphm-hours above 9.5 pphm/km^2.
[b] Only that portion of the county within the Air District's jurisdiction is included.

Area-weighted exposures appear to be slightly larger, on average, than population exposures. This suggests that more of the high ozone levels within counties are occurring in less populated areas.

The estimated decrease in District-wide area exposure between the 1986-88 base period and the 1991-93 period is 75%. Between 1991-93 to 1994-96, area exposure increased, but still there has been a net decrease of 36% overall from 1986-88 to 1994-96.